

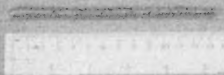
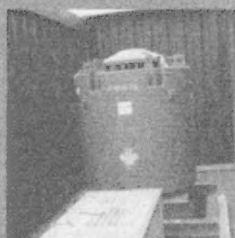
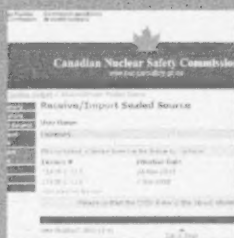
Canada's Nuclear Regulator



National Sealed Source Registry and Sealed Source Tracking System

Annual Report 2011

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Canadian Nuclear
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Canada

**National Sealed Source Registry and Sealed Source Tracking System Annual Report
2011**

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National Sealed Source Registry and Sealed Source Tracking System Annual Report 2011

Executive Summary

This sixth annual report provides information on the registration and tracking of radioactive sealed sources in Canada through the Canadian Nuclear Safety Commission's (CNSC) National Sealed Source Registry (NSSR) and Sealed Source Tracking System (SSTS), from January 1 to December 31, 2011. The report also describes developments made in the NSSR and SSTS during the same period.

The CNSC was the first nuclear regulator among G8 countries to develop a national registry and to implement an online tracking system, along with enhanced export and import controls for high risk sealed sources. These systems have been efficient and effective since their establishment in 2006.

The NSSR is a CNSC-managed national database that maintains inventory information on all categories of sealed sources in Canada. It contains detailed information on high risk (Categories 1 and 2) and some information on moderate (Category 3) to low-risk (Categories 4 and 5) radioactive sealed sources. This system, in conjunction with regulatory licensing and compliance operations, increases the security, safety and management of those sources. The NSSR's high-risk source tracking component, the SSTS, provides licensees and CNSC staff with an efficient, effective way to report and track the movement of high-risk sealed sources.

There were no major enhancements brought to the system in 2011, but work is underway to implement two major initiatives in 2012: the reprogramming of the system to comply with the Government of Canada's Web accessibility standard for people with disabilities, and a new secure online system to replace Access Key. In 2011, the CNSC pursued the development of a Web-based reporting module that will allow licensees to submit their annual compliance reports and update their sealed source inventories securely via the Internet. This will facilitate submission and verification of information on sealed sources in Categories 3, 4 and 5, and permit the CNSC to validate inventories of all nuclear substances. The development of this system is expected to continue through 2012 and 2013; it will eventually result in the registration and tracking of all categories of sealed sources in Canada.

By the end of 2011, the NSSR contained information on 43,371 radioactive sealed sources from all categories in Canada, representing an increase of 11% over the previous year. The SSTS was tracking 2,777 Category 1 sources and 22,778 Category 2 sources. The remaining 17,816 sources in the NSSR were in Categories 3, 4 and 5, which are not subject to mandatory tracking through the SSTS but are subject to reporting under CNSC regulatory oversight (licensing and compliance). The SSTS registered 53,083 individual transactions of all types throughout the year, representing a 1.4% increase over 2010; 83% were done via the online interface.

In 2011, the CNSC performed 227 inspections among licensees using the SSTS, where 221 or 97% of inspected licensees were found to be compliant. There were six inspections (or 3%) during which the licensees were found to have non-compliances, but in all cases the non-compliances in question did not severely affect the program's integrity. In addition, the CNSC monitors and tracks unplanned events involving the loss, theft and discovery of sealed sources in Canada. Sealed sources that are found in the public domain are immediately investigated, to ensure that safety and security are maintained and that the original owners responsible for the

material are identified. In 2011, there were 15 such reported events, with only one associated with a high-risk Category 2 source, which was found on the same day it had been reported lost. The other 14 events, 5 of which involved the discovery of previously lost or stolen sources, all involved low-risk Category 4 or 5 sources.

1. Introduction

Sealed sources are radioactive nuclear substances encased in a sealed capsule or in a cover to which the substance is bonded, and are used for a variety of activities, such as medical, industrial, academic and research as well as commercial applications. The Canadian Nuclear Safety Commission (CNSC) was the first nuclear regulator among G8 countries to develop a National Sealed Source Registry (NSSR) and to implement an online Sealed Source Tracking System (SSTS). In addition, enhanced controls were established for the import and export of high-risk sealed sources.

The CNSC manages Canada's national inventory of high-risk radioactive sealed sources by means of the NSSR. The safety and security of these sources is increased through effective control and tracking. This report provides information on the registration and tracking of high-risk radioactive sealed sources in Canada through the NSSR and SSTS systems, for the period of January 1 to December 31, 2011. The report also describes developments made to the systems during the same period.

This is the sixth annual report for the NSSR and SSTS. Additional information on the SSTS can be found on the CNSC Web site at nuclearsafety.gc.ca.

2. About the NSSR and SSTS Data

The SSTS is a secure information management computer program used to populate the NSSR, and allows licensees to report their source transfers online. The NSSR enables the CNSC to build an accurate and secure inventory of sealed sources in Canada, starting with those that are classified as high-risk. The information is as current as the reporting timeframes required by the licence (e.g., reporting within two days of receipt and seven days in advance of any transfer).

Sealed sources are classified by the IAEA into five different categories (see Appendix A), with Categories 1 and 2 designated as high risk (or risk-significant), Category 3 sources designated as moderate risk, and Categories 4 and 5 sources designated as low risk. The CNSC has focused its efforts to accurately capture data about these sources. Subsequently, the NSSR contains detailed information on Category 1 and 2 sealed sources in Canada, and limited information on sources in Categories 3, 4 and 5. Currently, as inventory information is received from licensees through their annual compliance reports (ACRs), the data is validated for accuracy and consistency, and compiled in tables. The upcoming rollout of an online ACR system, along with previously captured data, will facilitate the electronic registration of Category 3, 4 and 5 sealed sources in the NSSR.

3. Major Developments in 2011

3.1 Provisions for future initiatives

There were no major developments in 2011, except for regular maintenance work to fix minor system issues. However, work is underway to prepare the system for two major initiatives both planned for 2012 implementation. The first one will be to convert the system to a new application language compliant with the CNSC standard and the Web accessibility standard for people with disabilities. The other initiative is to prepare the SSTS for the new security access system for all Government of Canada's online services, which is planned to replace Access Key.

3.2 Registration of Category 3, 4 and 5 sources

The CNSC is maintaining data on all categories of sealed sources used, stored or transported in Canada, including sealed sources in Categories 3, 4 and 5. The CNSC is also designing a Web-based module, whereby licensees will be able to enter and revise their inventory data in their annual compliance reports. For more information on these initiatives, readers are invited to consult the *National Sealed Source Registry and Sealed Source Tracking System 2010 Annual Report*¹, available on the CNSC Web site. Due to technical issues, the initial roll-out of the online ACR system has been delayed to late 2012, and will continue throughout 2013.

3.3 International presentations

In March 2011, the CNSC delivered a presentation titled "Canadian Regulatory Requirements and Strategies for the Safe Handling of Radioactive Sealed Sources" at the International Source Suppliers and Producers Association Workshop in Vienna, Austria. The presentation featured an overview of Canada's regulatory oversight of sealed sources, along with the regulatory control of disused, lost, stolen and orphan sources.

Another presentation, titled "Implementation of the Code of Conduct on the Safety and Security of Radioactive Sources in Canada" was delivered in July 2011 at the IAEA meeting in Vienna, Austria. It provided an overview of Canada's export and import controls on radioactive sources.

3.4 Outreach program

As part of the Orphan Source Program initiative, the CNSC published, in 2010, a poster and an associated brochure², to provide guidance on how to respond to portal monitor alarms. The poster and brochure provide information to workers in the recycling industry, at landfill sites and other locations using radiation portal monitoring systems how to safely manage and handle nuclear substances, if these are detected. In 2011, the CNSC organized extensive outreach activities for the metal recycling and steel industry, to promote the use of this information when responding to the discovery of an orphan source. For more information on the Orphan Source Program, readers are invited to consult the *National Sealed Source Registry and Sealed Source Tracking System 2010 Annual Report*, available on the CNSC Web site.

¹ Available online at nuclearsafety.gc.ca/pubs_catalogue/uploads/NSSR_SSTS_2010_Annual_Report.pdf

² Available online at nuclearsafety.gc.ca/eng/readingroom/factsheets/alarm-response-guidelines.cfm

4. Performance Management

4.1 Performance measures and verification

In order to gauge the effectiveness of the SSTS program and verify the accuracy of data in the system, CNSC inspectors physically cross-reference data in the SSTS against the licensee's actual inventory of sealed sources. Routine CNSC compliance inspections include requirements to verify sealed source tracking information. Inconsistencies are immediately addressed to ensure accuracy in the data. These inconsistencies include errors in source serial numbers and reference dates, as well as the use of non-standard terminology when identifying sealed source assemblies.

In 2011, a total of 227 inspections were performed among those licensees for which mandatory tracking of high-risk sealed sources is required as a condition of their licence. These inspections covered the accuracy of the data related to sealed source transfers within Canada, as well as the accuracy of the licensee's inventory at their location at the time of inspection. In 2011, 221 of the inspected licensees (or 97%) were found to be compliant, up from 91% in 2010. The six remaining inspected licensees were found to have non-compliances that did not severely affect the program's integrity. In five cases, the sealed source inventory at the licensee's location did not match the information in the SSTS, because the sources had been moved to other locations without the proper notifications. In one case, the licensee had experienced issues with its secure access to the SSTS, and as a consequence one source had not been registered in the system. The CNSC ensures that the licensees implement appropriate corrective measures to address these issues and regain compliance with regulatory requirements. For more information on the performance results of Canadian licensees using nuclear substances, readers are invited to consult the *Nuclear Substances in Canada: A Safety Performance Report*³, available on the CNSC Web site.

4.2 Event mitigation

The NSSR and SSTS are essential to the maintenance of the safety and security programs for high-risk sealed sources. It is important for the CNSC to track and assist with the licensee's mitigation of all events involving sealed sources. Current CNSC regulations require all licensees to immediately report lost or stolen nuclear substances to the CNSC, with written descriptions of any actions taken, or proposed to be taken, in order to recover the missing material. Any loss or theft of high-risk or moderate-risk sealed sources requires the licensee to work with local police and other authorities to inform the public and to obtain any additional resources required to assist with the search and recovery. All events involving sealed sources are investigated and followed up by the CNSC, in order to ensure that the licensees take all the necessary actions to mitigate the event. If an event involves the loss or theft of a sealed source or radiation device, the CNSC informs national and international stakeholders which may assist with the recovery.

Information on lost and stolen nuclear substances can be found in the CNSC's *Lost or Stolen Sealed Sources and Radiation Devices Report*⁴, available on the CNSC Web site. The report lists all the lost, stolen and found sealed sources and radiation devices in Canada, as reported to the CNSC since 2005. As shown in Figure 1, there were 15 events involving lost, stolen or found

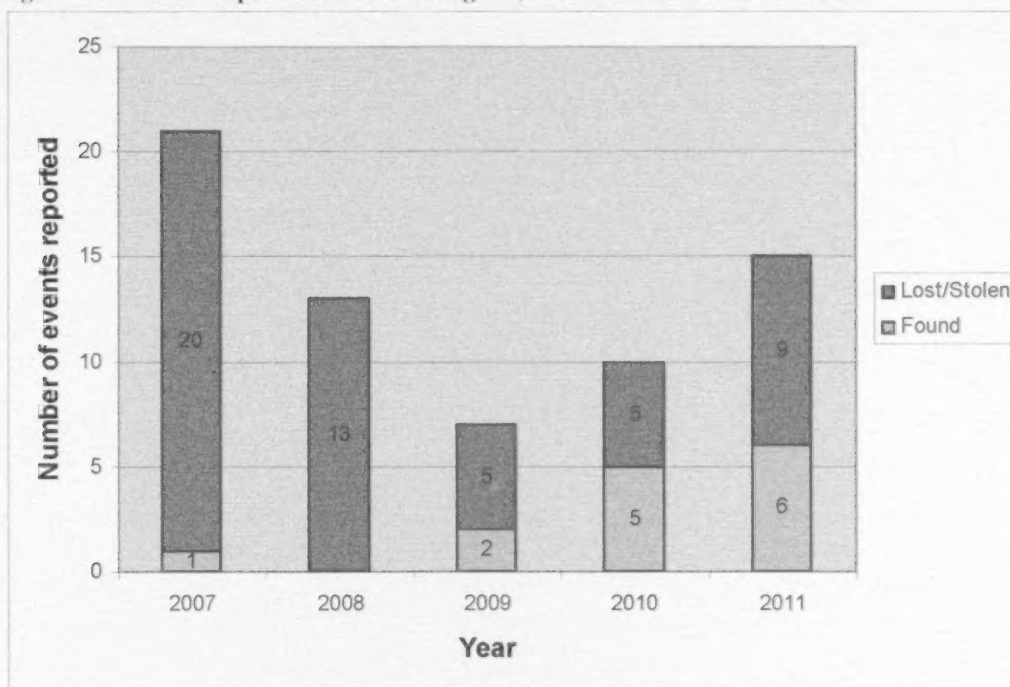
³ Available online at nuclearsafety.gc.ca/eng/readingroom/reports/use-of-nuclear-substances

⁴ Available online at nuclearsafety.gc.ca/eng/readingroom/reports

sealed sources in Canada during 2011. Although the total number of events has increased from the previous year, it is worth noting that six of these 15 events relate to the finding of sealed sources and devices (shown in blue on the figure). For the other nine events, the material was recovered in three instances; the remaining six events are under investigation. In some cases, a single event may involve more than one sealed source.

- There were no events involving **Category 1 or 3** sealed sources over the reporting period.
- One event involved **Category 2** high-risk sealed sources.
 - Found: The source was found on the same day it was reported lost.
- Seven events involved **Category 4** low-risk sealed sources. Category 4 sources are considered low-risk, and are unlikely to be dangerous to persons⁵.
 - Lost: Two events of lost sealed sources. In one case, the sealed source was recovered 22 days following its loss, while the other event is under investigation.
 - Stolen: Four events of stolen sources. For one event, the sealed sources were recovered on the same day that they were stolen. The other three events are under investigation.
 - Found: One event where sealed sources were lost in 2002 and found in 2011. Following their discovery, the sources were returned to the licensee and are now under proper regulatory control.
- Seven events involved **Category 5** sealed sources. Category 5 sources are very low-risk sealed sources, posing no personal danger to persons, due to their low activity, short half-life or their radiological nature.
 - Lost: Three events of lost sealed sources. In one case the sources were recovered the following day and the other two events are under investigation.
 - Found: Four events where sealed sources were found. In all cases, the sealed sources were characterized following their discovery and safely disposed of.

⁵ IAEA, *Categorization of Radioactive Sources*, RS-G-1.9, (2005), Table 3.

Figure 1: Number of reported events involving lost, stolen and found sealed sources

5. Planned Improvements and Objectives

5.1 Ongoing documentation

As enabling tools are created and modified, the internal documentation associated with the NSSR and SSTS will be revised. This includes any additions to the source activity decay calculator, category identification and licence number look-up table. In 2011, the CNSC developed and implemented an internal procedure for its staff on responding to the discovery of an orphan source.

5.2 Population of the NSSR with Category 3, 4 and 5 sources

In 2008, the CNSC started compiling data on sealed sources in Categories 3, 4 and 5. In 2009 and 2010, the CNSC began the design of a Web-based module, whereby licensees will be able to submit and update their yearly source inventories, using a secure online annual compliance report (ACR) system. The licensees will be able to enter their inventory data directly into structured data tables included in the online version of the annual compliance reports. Throughout 2012 and 2013, the CNSC will continue the implementation of this online system, which will facilitate the eventual inclusion of all sealed source categories in the NSSR. Meanwhile, the manual entry of data on Category 3, 4 and 5 sources in the NSSR, based on licensees' annual compliance reports, will continue until the online system is available.

5.3 International exchange of data

In late 2009, the CNSC and the United States Nuclear Regulatory Commission (USNRC) initiated discussions to determine the feasibility of an electronic exchange of sealed source

information between the CNSC's SSTS and the USNRC's National Source Tracking System. This exchange of data will provide essential information on authorized sealed source import and export transactions between Canada and the United States. There was no further development of this initiative in 2011; work is underway to establish an exchange of data starting in 2012.

5.4 Outreach program

As shown in Figure 4, the number of online transactions performed via the online interface has remained relatively constant over the past three years. The CNSC will be planning further outreach activities to promote the online usage of the system.

5.5 System enhancements

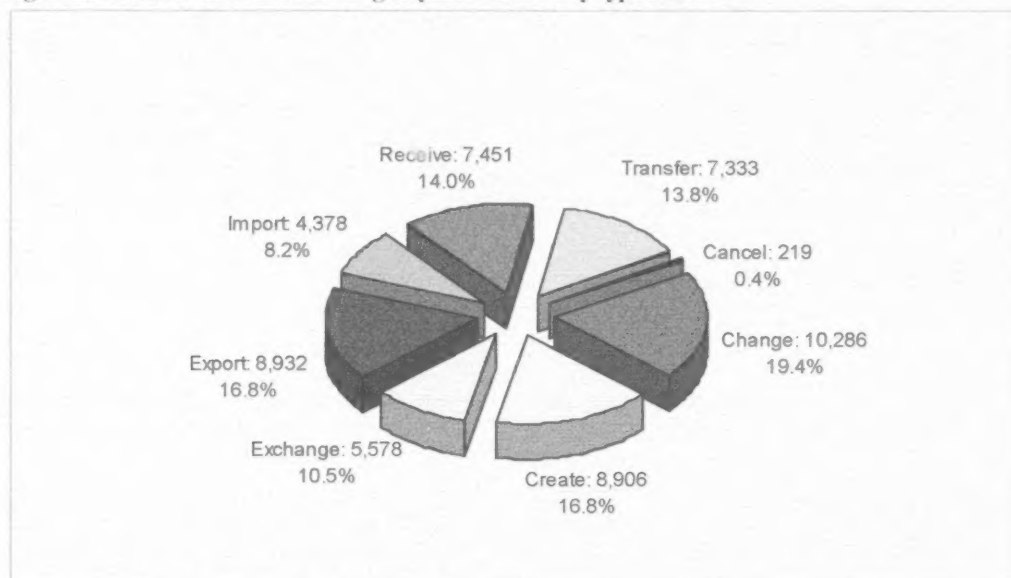
In 2010, the CNSC began the business case analysis for version 3 of SSTS. The results of this analysis could bring important modifications to the system in 2012.

6. Operational Data

6.1 National Sealed Source Registry statistics

During 2011, the NSSR continued to be populated with sealed source information for all categories, as licensees reported their transactions via the online interface or by other means (such as phone, fax, email and written submissions by regular mail). The following operational data encompasses the entire NSSR and SSTS. Figure 2 shows all the transactions reported in 2011, which include transfers, receipts, imports, exports, cancellations, changes, creations and exchanges.

Figure 2: National Sealed Source Registry transactions by type for 2011



Types of transactions

Receive:	sources received by licensees at licensed locations
Transfer:	sources transferred within Canada between licensees and licensed locations
Cancel:	cancel a transaction due to unforeseen circumstances (export and shipment cancellations and delayed transfers)
Change:	data change or correction (e.g., to reference date of source activity)
Create:	creation of a new source manufactured in Canada, or recording of sealed sources in secure storage awaiting disposal
Exchange:	replacement of one source for another in a device or prescribed equipment, at a licensed location
Export:	sources shipped out of Canada
Import:	sources shipped into Canada

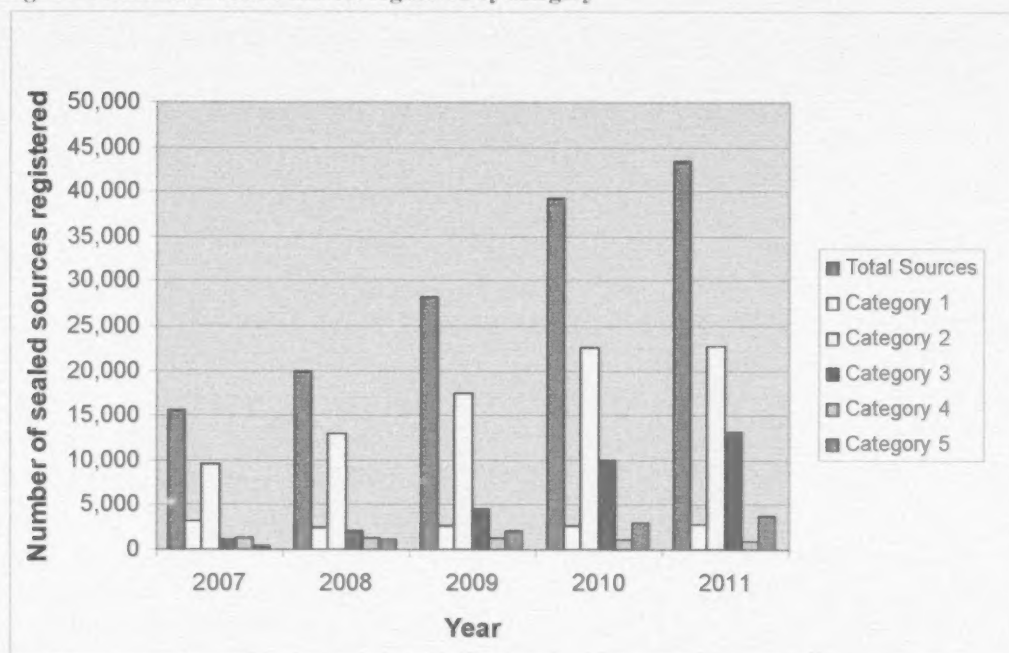
Table 1 and Figure 3 show the total number of sources in the NSSR as of December 31 of each year, as well as the breakdown by Category⁶. The number of sources continued to increase in 2011, as higher risk sources naturally decayed to lower categories and as more licensees added Category 3, 4 and 5 sources as an integral part of their overall inventory. The number of Category 1 and 2 high-risk sources, subject to mandatory source tracking, varied with the number of sources created, disposed of, and imported or exported by manufacturers and licensees.

Table 1: National Sealed Source Registry statistics

	2007	2008	2009	2010	2011
Number of sources in NSSR (all categories) in Canada	15,538	19,847	28,132	39,263	43,371
Number of category 1 sources tracked in Canada	3,224	2,410	2,702	2,608	2,777
Number of category 2 sources tracked in Canada	9,523	12,881	17,530	22,541	22,778
Number of category 3 sources recorded in the registry	1,186	2,137	4,578	10,051	13,092
Number of category 4 sources recorded in the registry	1,312	1,273	1,263	1,094	1,006
Number of category 5 sources recorded in the registry	293	1,146	2,059	2,969	3,718

⁶ "Categorization of radioactive sources", IAEA TECDOC-1344, 2003.

Figure 3: Number of sealed sources registered by category



6.2 Online usage

With the system design enhancements implemented in 2008, online usage has initially increased but seems to have stabilized in the past three years. In 2011, there were a total of 53,083 transactions, representing all transactions for the NSSR and SSTS systems, which amounted to an increase of 1.4% from 2010. With respect to online usage, Figure 4 shows that 83% of these transactions were done via the online interface in 2011, a decrease from 86% in 2010. In fact, the number of online transactions remained relatively stable from 2010 to 2011, whereas the number of transactions conducted by phone, fax, mail and email, has slightly increased. This increase may be due to unexpected problems with the system, causing users to perform manual transactions for a short period, or infrequent users of the SSTS suddenly having to report a large number of sources. Figure 5 shows the comparison of manual transactions conducted by phone, fax, mail and email versus those conducted online. These numbers seem to indicate a need to perform outreach activities should the CNSC want to promote and increase online usage in the future.

Figure 4: Sealed Source Tracking System online transactions relative to total number of transactions

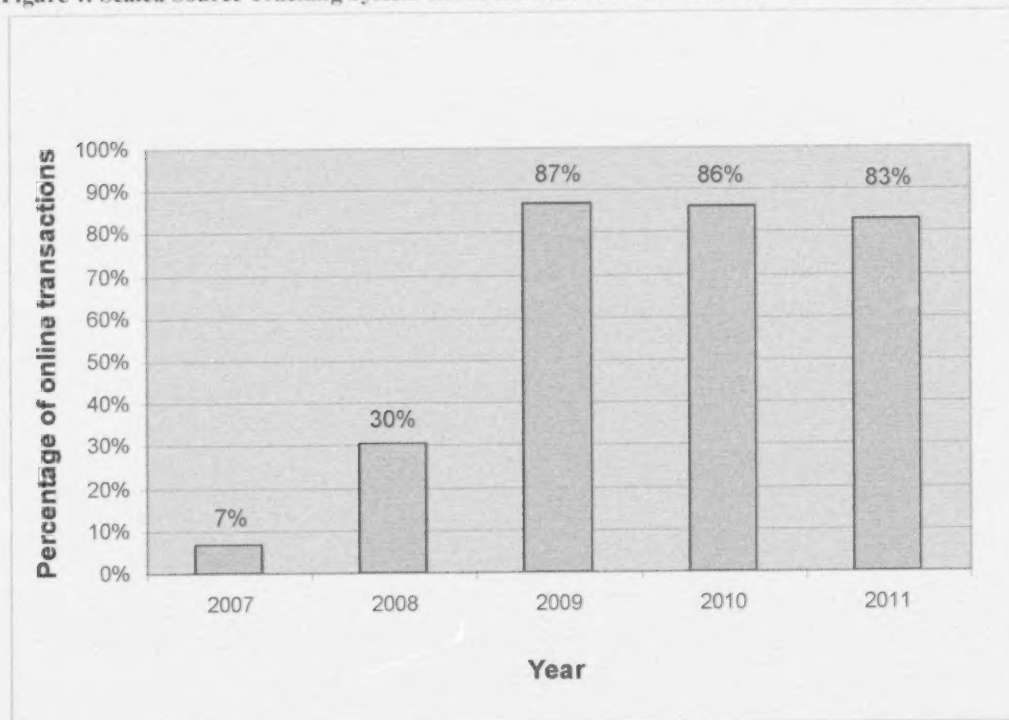
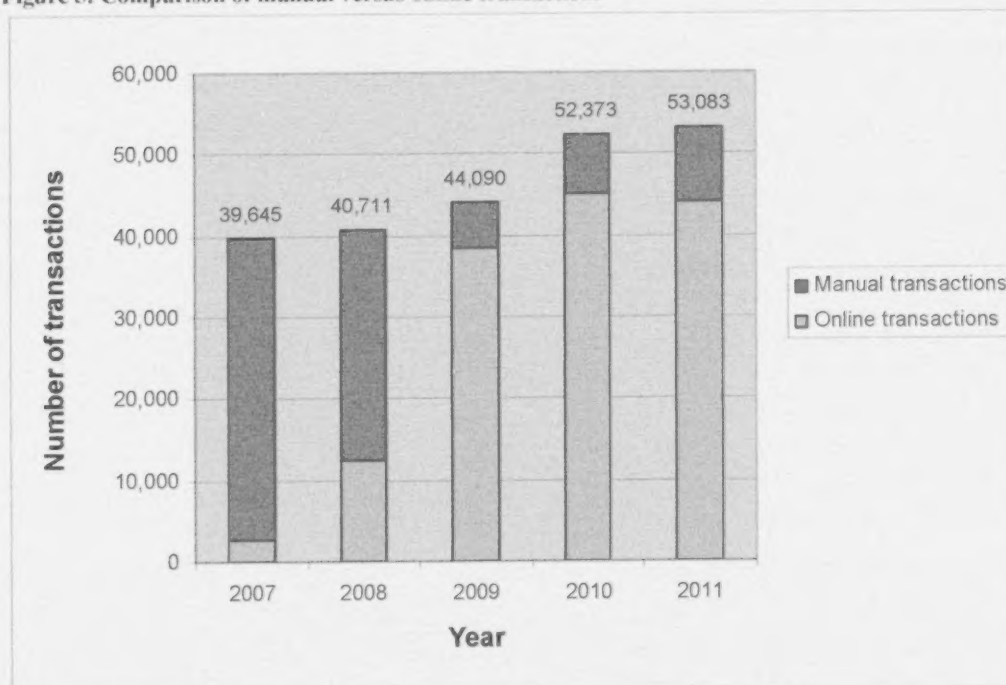


Figure 5: Comparison of manual versus online transactions



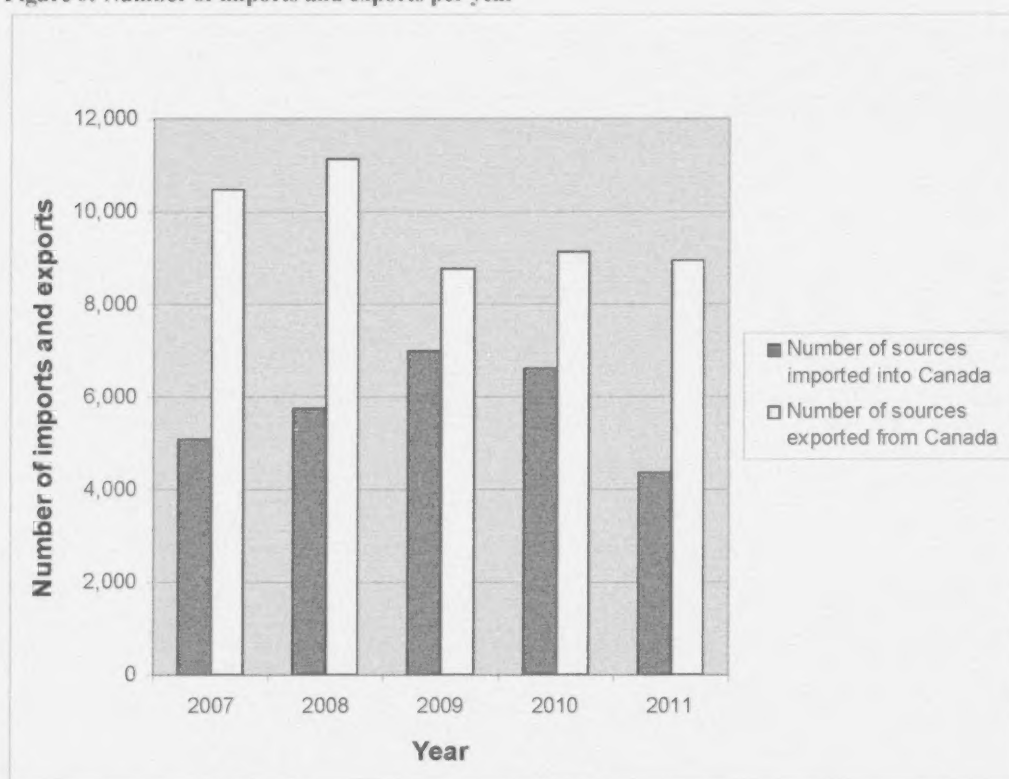
6.3 Import and export details

Table 2 and Figure 6 below show the number of import and export transactions in SSTs, as of December 31 of each year. Canadian licensees routinely import sealed sources and export them in accordance with their licences.

Table 2: Import and export statistics per year

	2007	2008	2009	2010	2011
Number of sources imported into Canada	5,093	5,763	6,995	6,622	4,378
Number of sources exported from Canada	10,476	11,127	8,746	9,135	8,932

Figure 6: Number of imports and exports per year



7. Conclusion

The NSSR and SSTS contain information on the movement and location of high-risk radioactive sources in Canada, from their manufacture to their final disposition. The CNSC was the first nuclear regulator among the G8 countries to implement a national registry of high-risk sealed sources and monitor their movement using an online tracking system.

There were no major developments or system enhancements performed in 2011, but major initiatives are planned to be implemented in 2012. Statistics show a 1.4% increase in the number of transactions from 2010. The number of online transactions remained relatively constant, whereas the number of transactions performed manually slightly increased. Current performance measures and data verification and validation are under continuous review, and are being improved as required. Compliance inspection results in 2011 show an increase in the percentage of inspected licensees that were found to be compliant to the sealed source tracking requirements, when compared to 2010 results. This indicates an ongoing licensee commitment to the NSSR and SSTS and reflects the system's effectiveness, which contributes to ensuring the safe and secure management of sealed sources in Canada.

Appendix A: Categorization of sources

Radioactive sealed sources are used throughout the world in medicine, industry, agriculture, research and education, and vary widely in radiological risk. In 2005, the IAEA published a risk-based ranking of radioactive sources and practices, which uses five categories⁷. The category assigned to each practice or radioactive nuclear substance (which the sealed source is made of) takes into account factors such as the following:

1. The radiological risk associated with the source
2. The nature of the work (or application for which the source is used)
3. The mobility of the source, experience from reported accidents
4. Typical versus unique activities within an application

These factors were used to assign sources and practices to one of five categories. If not managed safely and securely, Category 1 sources are considered to pose the greatest risk to human health, while Category 5 sources pose the lowest risk⁸.

A.1 Category 1 (very high risk)

Category 1 sources are classified as “personally extremely dangerous”.

This radioactive material, if not safely managed or securely protected, would be likely to cause permanent injury (in some cases fatal) to a person handling or coming in contact with the material for a period of a few minutes. Exposure would be fatal if a person were close to it in an unshielded manner for a few minutes to an hour. Category 1 sources are associated with licensed activities to which the CNSC *Class II Nuclear Facilities and Prescribed Equipment Regulations* apply.

Examples of Category 1 source usage:

- Self-shielded irradiators: Gamma sources are used in these irradiators for experimental purposes or as a means of sterilization. Gamma irradiation kills bacteria by breaking down bacterial DNA and inhibiting cell division. Blood products, for example, are sterilized in self-shielded irradiators.



Image 1: Cobalt 60 gammacell.

⁷ IAEA, Categorization of Radioactive Sources, RS-G-1.9 (2005).

⁸ IAEA, Categorization of Radioactive Sources, RS-G-1.9 (2005), Table 3.

Gamma knife radiosurgery: An advanced form of surgery, performed with highly focused beams of radiation. As many as 201 radioactive sealed sources create intersecting beams of gamma radiation, which deliver a concentrated dose of radiation to a precise area of the brain. These radiation beams form the “knife”.



Image 2: Elekta gamma knife.



Image 3: Gamma knife in use.

- Radioactive source teletherapy: External beam radiotherapy, otherwise known as “teletherapy”, is the most frequently used form of radiotherapy. Radiotherapy is the medical use of radiation (produced by a radioactive sealed source mounted inside the machine) as part of cancer treatment or to control malignant cells.



Image 4: Cobalt 60 teletherapy.

A.2 Category 2 (high risk)

Category 2 sources are classified as “personally very dangerous”.

This radioactive material, if not safely managed or securely protected, could cause permanent injury to a person handling it or coming in contact with it for a short period of time (minutes to hours), or be fatal if close to it in an unshielded manner for a few days. Category 2 sources are associated with licensed activities to which the CNSC *Nuclear Substances and Radiation Devices Regulations* generally apply.

Example of Category 2 source usage:

- Industrial radiography is a non-destructive testing (NDT) application that uses gamma radiation from a highly radioactive source, and photographic film, for the detection of internal physical imperfections (such as voids, cracks, flaws, segregations, pores and inclusions) in pressure vessels, pipelines, ships and reactor components. Radiography produces images on photographic film, similar to X-ray images, which show varying densities according to the amount of radiation absorbed in the material.

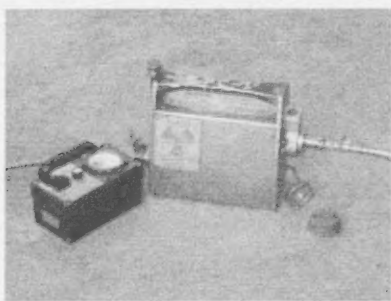


Image 5: Industrial radiography camera, which contains a radioactive sealed source.



Image 6: NDT pipeline inspection using industrial radiography equipment.

A.3 Category 3 (moderate risk)

Category 3 sources are classified as “personally dangerous”.

This radioactive material, if not safely managed or securely protected, could cause permanent injury to a person either handling it, or otherwise coming in contact with it, for some hours. Although unlikely, it could be fatal to be close to this amount of unshielded radioactive material for a period of days to weeks. Category 3 sources are associated with licensed activities to which the CNSC *Nuclear Substances and Radiation Devices Regulations* apply.

Examples of Category 3 source usage:

- Industrial gauges: These gauges are usually installed in fixed positions for measuring and process control purposes. These include density gauges, level gauges, belt mass meters, and thickness gauges. The radioactive sealed source is mounted inside the gauge and projects a radiation beam, through the material, and is picked up by a detector to provide a measurement.



Image 7: Industrial fixed gauge.

- Brachytherapy delivers a concentrated dose of radiation to cancerous tissue from within. High dose rate (HDR) brachytherapy is the placement of a small, highly radioactive sealed source, for a short period of time, directly into cancerous tissues. The procedure is sometimes guided by ultrasound or 3D computerized mapping techniques.

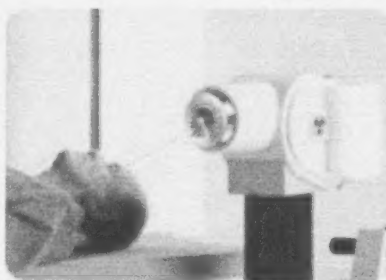


Image 8: HDR brachytherapy.

A.4 Category 4 (low risk)

Category 4 sources are classified as “unlikely to be personally dangerous”.

It is very unlikely that anyone would be permanently injured by this radioactive material. However, if this unshielded radioactive material is not safely managed or securely protected, although unlikely, it could temporarily injure someone handling it, in contact with it, or who is close to it for several weeks. Category 4 sources are associated with licensed activities to which the CNSC *Nuclear Substances and Radiation Devices Regulations* apply.

Example of Category 4 source usage:

- Low dose rate industrial gauges, such as moisture and density gauges, are used to measure the density of asphalt, soil, aggregate or concrete, as well as the moisture content of soil or aggregate.



Image 9: Portable gauge.



Image 10: Portable gauge in use.

Category 5 sources are classified as “most unlikely to be personally dangerous”.

Category 5 (very low risk):

No one could be permanently injured by this radioactive material. Category 5 sources are associated with licensed activities to which the CNSC *Nuclear Substances and Radiation Devices Regulations* apply.

Examples of Category 5 source usage:

- Nickel 63 sources, in electron capture detectors, are used in gas chromatography instruments. They detect minute amounts of chemical compounds, such as halogenated organic chemicals in environmental samples. Pesticide levels in foodstuffs, for example, are measured with these detectors.
- Low dose rate (LDR) brachytherapy involves exposure to small radioactive sealed sources for a few hours or days. Ocular melanoma is one example of a tumour that can be treated with LDR brachytherapy. In another example, radioactive seeds of Iodine 125 are surgically implanted to treat prostate cancer.

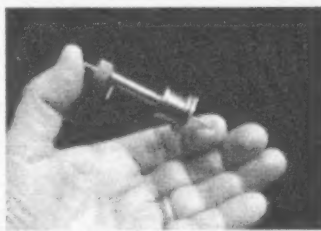


Image 11: Nickel 63 sealed source used in electron capture detectors.

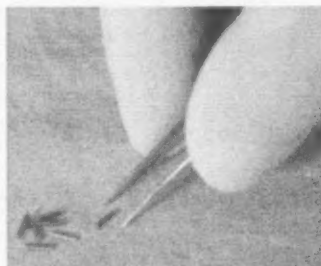


Image 12: LDR brachytherapy.